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Ethno-medical Profiling of *Myrianthus arboreus* P. Beauv: A Phyto-resource Food of Chimpanzees (*Pan troglodytes* Blumenbach, 1799) in the Ubangi Eco-region of Democratic Republic of the Congo

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ABSTRACT

The aim of this study was to evaluate the ethnomedical knowledge of the population of South Ubangi on *Myrianthus arboreus*, a plant consumed by chimpanzees, with the assumption that this bio-resource is also used by the population in African Traditional Medicine to treat common diseases. The results revealed that *M. arboreus* treats 23 diseases in the province of South Ubangi in Democratic Republic of the Congo. Of these diseases, six (anaemia, bronchitis, tooth decay, gastritis, hypertension, and spleen) are the most cited. Anaemia and spleen are treated by all socio-cultural groups. The leaf is the most used organ (48%) followed by sap, roots, stems, bark, flowers, and seeds. Expression (61.5%) is the most used method of preparation followed by decoction, maceration, and mastication. Oral (94.5%) is the most used method of administration followed by body bath, massage, anal and auricular route. *M. arboreus* is a vulnerable species ($Iv \geq 2.5$) in the study area. The diseases treated are influenced by the level of education and the profession of the respondents ($p < 0.05$). While the mode of preparation of recipes is influenced by the family situation, also the composition of recipes is influenced by gender, age and occupation ($p < 0.05$). The search for new sources of bio-inspired drugs through zoopharmacognosy may thus allow the development of effective phytomedicines for the health care of humans or non-human primates *ex situ*. Thus the need for advanced phytochemical and pharmacological studies and the domestication of *M. arboreus* for its multiple food and pharmacological uses is necessary.

Keywords: Great apes; Zoopharmacognosy; Traditional medicine; Myrianthus arboreus; Domestication

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1. Introduction

Infectious diseases pose a real threat to the survival of humans and non-human primates (NHPs). They can affect the behavior and ability of animals to reproduce in their natural habitat [1]. Due to their phylogenetic proximity, these primates are characterized by their susceptibility to a large number of infectious pathogens (viruses, bacteria, protozoa, helminths, etc.). It has been shown that humans and NHPs have developed similar immune systems during ontogenic evolution and are susceptible to similar infectious diseases [2,3]. Indeed, the major histocompatibility complex class I genes required for the recognition of antigens responsible for parasitic infections are functionally similar in the genera Homo and Pan [4,5]. However, some diseases (e.g. malaria, etc.) common to both humans and HNPs can be fatal in humans, whereas they are less severe and have little or no effect on NHPs [6,7]. These NHPs use various plants for food (primary metabolites) or for self-care (secondary metabolites with pharmacological properties) [8,9]. Such self-medicating behavior also called "zoopharmacognosy" would play a key role in maintaining host-pathogen balance in NHPs and thus in coevolution through the prophylactic activity of plant food resources (nutritherapy). These plant genetic resources are also used by humans because of their therapeutic effects. Thus, zoopharmacognosy constitutes a means for understanding the phenomenon of host-parasite coevolution that can help humans to cope with emerging and re-emerging diseases. Indeed, in order to cope with infectious parasites in the natural environment, the animal kingdom has developed an anti-parasitic behaviour consisting of the use of secondary metabolites of plant origin as chemical defenses for its protection. This plant-animal association is a special case of symbiotism, which has inspired humans since prehistoric times as a source of traditional medicines. Indeed, in the forest regions of tropical Africa (notably the Congo Basin), humans cohabit with NHPs and all use a number of the plants to combat parasitic infections [1]. Such strategy maintains the balance between the host and pathogen and facilitates coevolution. Self-medication behavior in wild animals is an approach that allows the local population to identify new sources of medicines for the traditional treatment of diseases in the forest environment.

Considering the high degree of phylogenetic proximity that exists between chimpanzees and humans, the present study was initiated to assess the ethnomedical knowledge of the population of South Ubangi on *Myrianthus arboreus*, a plant consumed by chimpanzees, on the assumption that this food phytogenetic resource is also used by the population in African Traditional Medicine to treat common diseases. The aims of this study are to determine the sociodemographic parameters of the respondents, to identify the diseases treated by this plant, the organs used, its availability in the area, and the factors that influence the use of this plant genetic resource in South Ubangi.

2. Materials and methods

2.1 Study area

The present study was carried out in the province of South Ubangi in the Democratic Republic of Congo. This province is located in the Ubangi ecoregion, which is considered a sub-region of the northeastern Congolese forests. It is one of the 200 global priority terrestrial ecoregions also known as the "G200" [10]. **Figure 1** shows the geographical location of this province.

2.2 Plant material and its choice

In this study, the plant material was *Myrianthus arboreus*, a food resource for chimpanzees.

2.3 Methods

Survey period and sampling

A pre-survey was first conducted in April 2022 (with 50 respondents) followed by the actual survey

from 23 May to July 2022. The pre-survey showed that 85% of the respondents had good ethnobotanical knowledge of *M. arboreus*. Thus, considering a margin of error of 5%, the sample size was estimated at 196 individuals and then rounded up to 200. The sample size is calculated by the Dagnelie formula [11] as follows:

$$n = \frac{p(1-p)z^2}{\varepsilon^2}$$

where z is the normal random variable and corresponds to 1.96 when alpha (α) is equal to 5%; ε is the allowed margin of error (5%) and p is the proportion of people with knowledge about the ethnobotanical value of *M. arboreus* (p=0.85). The stratified probability sampling method (also called proportional stratified random sampling) was adopted. Thus, the study area was divided into five strata and for each stratum, 40 people belonging to the same ethnic group were interviewed [11,12-14].

Data collection

The present study was conducted among five socio-cultural groups (Bomboma, Lobala, Mbanza, Ngbandi, and Ngombe) in the province of South Ubangi. The interview was conducted in Lingala. Survey forms designed by the "Laboratoire d'Ethnobiologie & Phytochimie Médicale" (Department of Biology, Faculty of Science & Technology, University of Kinshasa) were used as a basis for the interviews. The questions included information on socio-demographic characteristics (sex, age, socio-cultural group, and profession); ethnobotanical data (organs used, methods of preparation, diseases treated, etc.), and the availability of the species in the area.

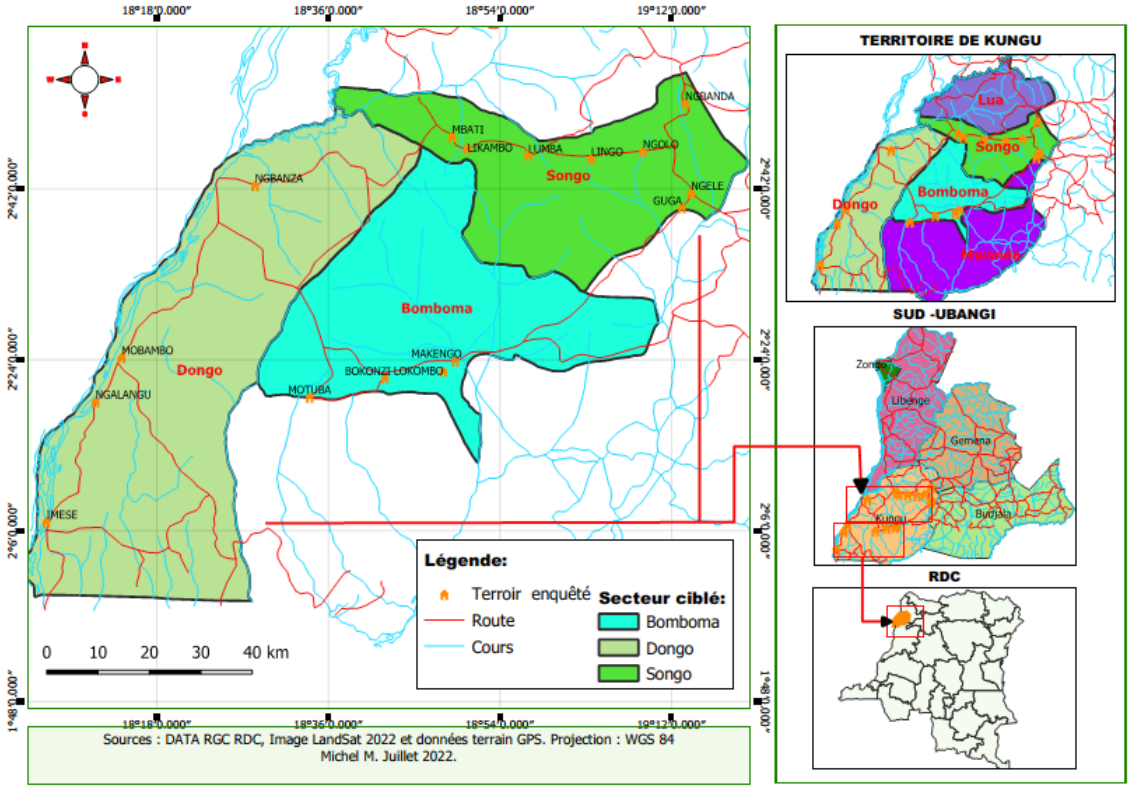

Figure 1. Geographical location of the South Ubangi province (study area).

Data processing and analysis

The socio-cultural importance of *Myrianthus arboreus* according to the socio-cultural groups surveyed was assessed using two ethnobotanical parameters namely the Consensus Disease Value (CDV) and the Frequency of Citing (FC) and the Vulnerability Index (Iv) of the plant as previously described [13].

Microsoft Excel version 2010, IBM SPSS Statistics version 20, Origin version 8.5 Pro and Past version 4.0 were used for data processing and analysis. The collected data are first encoded in Microsoft Excel and then analyzed in IBM SPSS Statistics. Univariate analyses are performed on the categorical variables (socio-demographic and ethnobotanical variables) to obtain descriptive statistics (relative frequencies). The Kolmogorov-Smirnorv test is carried out to confirm the normality of the distribution of the quantitative variables. Bivariate analyses are performed to examine the associations or links between the dependent variables (ethnobotanical parameters) and the independent variables (socio-demographic parameters). Associations between categorical variables are assessed using the Pearson Chi-square statistical test. Multivariate analyses (principal component analyses) are carried out in order to identify, from all the components or factorial axes (initial variables); those that can better explain the use of the plant in the management of the diseases listed by grouping them according to their correlation coefficients.

Ethical considerations

The research protocol for this study was approved by the Ethics Committee of the Department of Life Sciences of the University of Kinshasa. The study respected the principles of the Declaration of Helsinki (free consent of respondents, etc.). All rules of confidentiality and ethics as well as the rules of access and benefit sharing (ABS) related to the use of plant genetic resources in the Democratic Republic of the Congo were respected in this study. Respondents were informed that participation in the survey is voluntary and not subject to any coercion. They were informed that the results of this study will be returned to them in the form of open-access articles for dissemination by local leaders.

3. Results

3.1 Sociodemographic data

Figure 2 shows the age distribution of respondents in the study area.

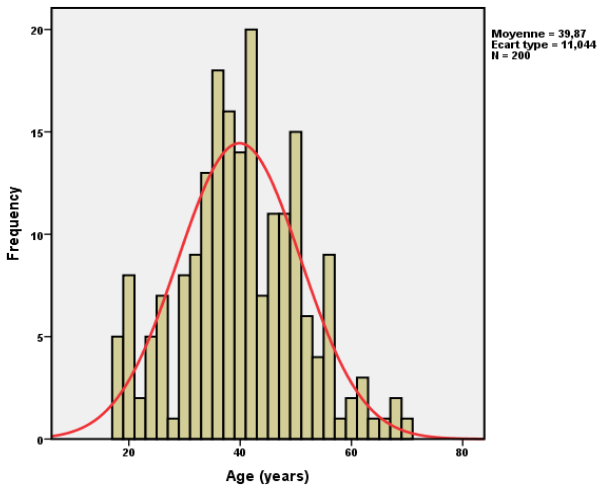

Figure 2. Age distribution of respondents in the study area.

(Legend: Moyenne = mean; Ecart type = standard deviation; N = sample size)

The figure shows that for a sample size of 200, the minimum age was 18 years, the maximum age was 70 years and the mean age was 39.87 ± 11.044 years. Statistical analysis according to Kolmogorov-Smirnov [ddl (200) = 0.069, p = 0.021] or Shapiro-Wilk [ddl (200) = 0.986, p = 0.047] shows that the age distribution of the respondents does not follow a normal distribution ($p < 0.05$) in the population of the surveyed area. Note that among the Lobala, the minimum age was 18 years, the maximum age was 62 years and the mean age was 37.70 ± 10.792 years (n = 40). Among the Ngbandi, the minimum age was 18 years; the maximum age was 61 years and the mean age was 36.07 ± 10.499 years (n = 40). Among the Bomboma, the minimum age was 18 years; the maximum age was 66 years and the mean age was 41.53 ± 10.775 years (n = 40). Among the Ngombe, the minimum age was 19 years; the maximum age was 64 years and the mean age was 41.65 ± 11.012 years (n=40). Among the Mbanza, the minimum age was 19 years, the maximum age was 70 years and the mean age was 42.38 ± 11.236 years (n = 40).

Table 1 shows the frequency of socio-demo-

graphic parameters of the respondents.

Table 1 shows that the majority of respondents are aged between 36-50 years, i.e. 52%. This is followed by those aged between 18-35 years, i.e. 33%, and finally those aged over 50 years, who represent 12%. The majority of respondents were men, 64.5%, compared to women, who represented 34.5%.

The majority of respondents have secondary education, i.e. 63.5%. This is followed by those with primary education (18.5%), university graduates (15%), and illiterates (3%). The majority of respondents are farmers, i.e. 38%. They were followed by teachers (35.5%), housewives (22%), the unemployed (2.5%), traditional practitioners (1%), and finally agronomists and traders (0.5%). The majority of respondents were married, i.e. 90%, compared to single people, who represented 10%.

Table 2 shows the distribution of respondents according to age and ethnicity.

Table 2 shows that the majority of respondents were young (18-35 years) among the Lobala, while among the other ethnic groups (Mbanza, Bomboma, Ngbandi, and Ngombe), adults were more numerous (36-50 years).

Table 1. Socio-demographic parameters of respondents.

Socio-demographic parameters		Frequency	Percentage
Age group			
	> 50 years	30	15.0
	18-35 years	66	33.0
	36-50 years	104	52.0
	Total	200	100.0
Gender			
	Female	71	35.5
	Male	129	64.5
	Total	200	100.0
Education level			
	Illiterate	6	3.0
	Primary	37	18.5
	Secondary	127	63.5
	University	30	15.0
	Total	200	100.0
Profession			
	Agronomist	1	0.5
	Unemployed	5	2.5
	Trader	1	0.5
	Cultivator	76	38.0
	Teacher	71	35.5
	Housekeeper	44	22.0
	Tradipractor	2	1.0
	Total	200	100.0
Marital status			
	Single	20	10.0
	Married	180	90.0
	Total	200	100.0

Table 2. Distribution of respondents by age and ethnicity

Age group		Ethnic groups					Total
		Bomboma	Lobala	Mbanza	Ngbandi	Ngombe	
	> 50 years	8	4	7	2	9	30
	18-35 years	9	19	8	17	13	66
	36-50 years	23	17	25	21	18	104
Total		40	40	40	40	40	200

Table 3 shows the distribution of respondents according to age and level of education.

Table 3 shows that regardless of age, the majority of respondents have a secondary education.

Table 3. Distribution of respondents according to age and level of education.

Age group		Education level				Total
		Illiterate	Primary	Secondary	University	
	> 50 years	2	10	12	6	30
	18-35 years	1	13	44	8	66
	36-50 years	3	14	71	16	104
Total		6	37	127	30	200

Table 4 shows the distribution of respondents according to ethnic group and level of education.

Table 4 shows that, regardless of ethnic group, the majority of respondents had a secondary education, except for the Ngombe, where the same number had a university education.

Table 4. Distribution of respondents according to ethnic group and level of education.

Ethnic groups		Education level				Total
		Illiterate	Primary	Secondary	University	
	Bomboma	0	5	27	8	40
	Lobala	1	2	31	6	40
	Mbanza	4	9	27	0	40
	Ngbandi	0	14	26	0	40
	Ngombe	1	7	16	16	40
Total		6	37	127	30	200

Table 5 shows the distribution of respondents according to gender and level of education.

Table 5 shows that, regardless of gender, the majority of respondents had a secondary education. It can also be noted that there were more university graduates among the men than among women, thus raising the need to encourage the enrolment of girls in school and their support up to a higher level.

Table 5. Distribution of respondents by gender and education level.

Gender		Education level				Total
		Illiterate	Primary	Secondary	University	
	Female	3	21	42	5	71
	Male	3	16	85	25	129
Total		6	37	127	30	200

Table 6 shows the distribution of respondents according to gender and level of education.

Table 6 shows that irrespective of gender, there were more married respondents than single respondents.

Table 6. Distribution of respondents by gender and education level.

Sex		**Marital status**		**Total**
		Single	Married	
	Female	12	59	71
	Male	8	121	129
Total		20	180	200

Table 7 shows the distribution of respondents by gender and ethnic group.

Table 7 shows that regardless of ethnic group, the majority of respondents were male, except among the Lobala where women were more numerous.

3.2 Ethnobotanical data

Figure 3 shows the different parts of *Myrianthus arboreus* used.

Figure 3 shows that the most used part is the leaf, 48%. This is followed by the sap (18%), the roots and stems (8.5% each), the bark (6%), and finally the flowers and seeds which represent 5.5% each.

Figure 4 shows the different diseases treated by *Myrianthus arboreus* in traditional medicine.

Figure 4 shows that the most common disease treated is anaemia (33/200), followed by bronchitis (31/200), gastritis (18/200), tooth decay (17/200), spleen (14/200), hypertension (10/200). Other conditions (cough, hemorrhoids, diarrhea, asthma, boils, dehydration, yellow fever, angina, epilepsy, viral hepatitis, headaches, lower abdomen, infections, malaria, foot oedema, measles, visual disturbance, and dermatitis, low back pain, panic attacks, and weight loss) have a low frequency of citation.

Table 7. Distribution of respondents by gender and ethnic group.

Gender		**Ethnic groups**					**Total**
		Bomboma	Lobala	Mbanza	Ngbandi	Ngombe	
	Female	13	24	13	11	10	71
	Male	27	16	27	29	30	129
Total		40	40	40	40	40	200

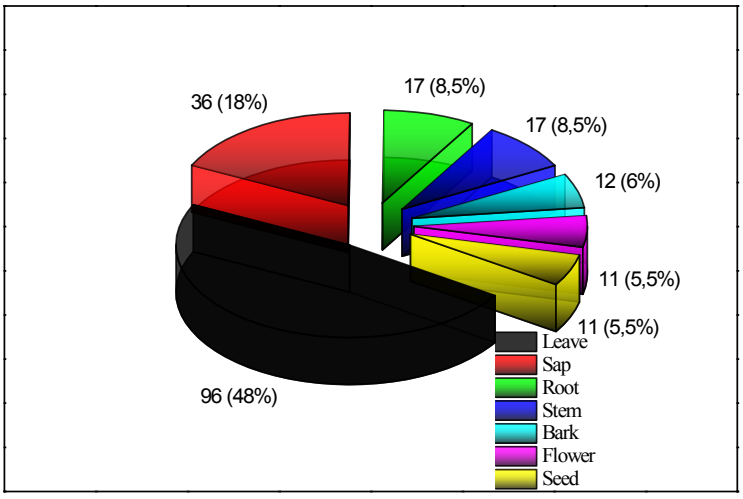

Figure 3. Used parts of *Myrianthus arboreus*.

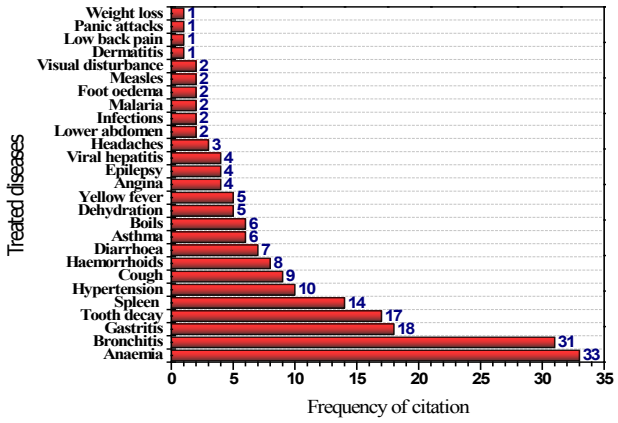

Figure 4. Diseases treated by *Myrianthus arboreus.*

Figure 5 shows the different ways of preparing *Myrianthus arboreus* recipes, while **Figure 6** shows the routes of administration.

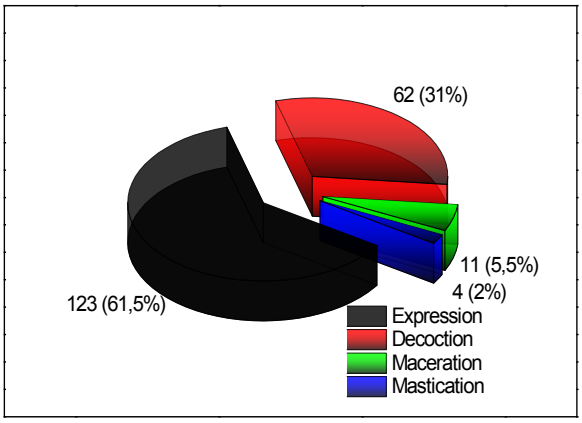

Figure 5. Recipe preparation methods.

Figure 5 shows that the most commonly used method of preparation is an expression, which accounts for 61.5%. This is followed by decoction (31%), maceration (5.5%), and finally mastication (2%).

Figure 6 shows that the most commonly used route of administration is oral (94.5%). This is followed by the body bath, massage and anal route (1.5% each). The ear route accounts for only 1%.

Figure 7 gives the composition of recipes while **Figure 8** gives the availability of the plant in the environment.

Figure 7 shows that the majority of respondents used the plant alone without combining it with another plant (i.e. 96.5%), while 3.5% of the respondents used the plant in combination with other plants.

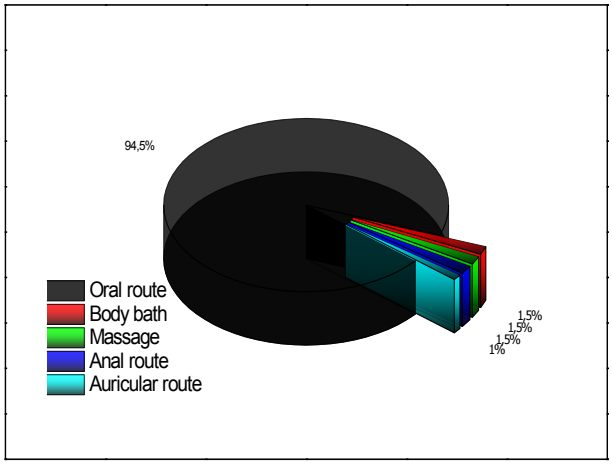

Figure 6. Recipe administration methods.

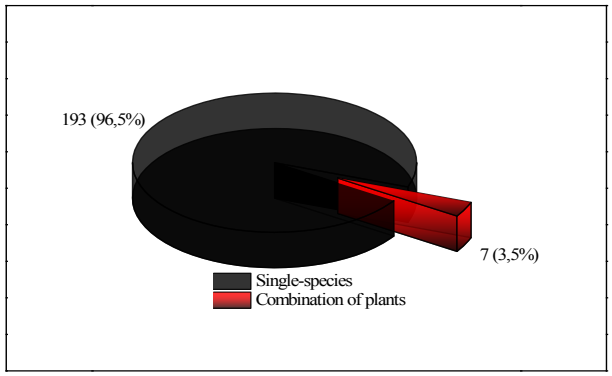

Figure 7. Composition of recipes.

Figure 8 shows that the majority of respondents (78.5%) confirm that the plant has become rare in the area. While 21.5% of the respondents said that the plant was not very abundant in the area.

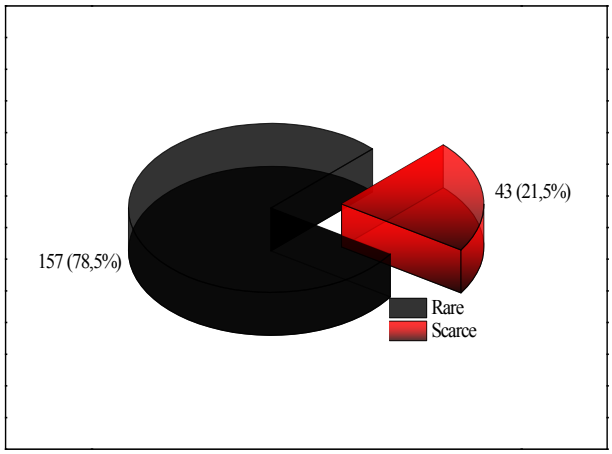

Figure 8. Availability of *Myrianthus arboreus* in the study area.

Table 8 gives the consensus value of the diseases and their frequency of mention.

Analysis of two ethnobotanical indicators, such as the consensus value of diseases and the frequency of citation, shows that six diseases (anaemia, bronchitis, tooth decay, gastritis, hypertension, and spleen) were the most cited (**Figure 4** and **Table 8**), and have received consensus from the respondents. Anaemia and spleen are treated by all socio-cultural groups.

The vulnerability index of *Myrianthus arboreus* is presented in **Table 9**.

Table 9 shows that *Myrianthus arboreus* is highly vulnerable (Iv ≥ 2.5) in the study area. According to Ngbolua [13], the vulnerability of a plant depends on a number of parameters including frequency of use, morphological type, and abundance in the environment, ethno-medical use, and parts used, biotope, mode of diaspora dissemination, stage of development of the plant and mode of collection. This index shows that if no strategy is adopted in the short term, there is a risk of extinction of this plant species, which is useful both for humans (medicine) and for great apes (food resources). It is therefore urgent to domesticate it with a view to creating a productive ecosystem (source of raw materials for the manufacture of phytomedicines, carbon sink, etc.).

3.3 Statistical analysis

Bi-variate analysis

Statistical analysis indicated that the parameter "disease treated" was influenced by the respondent's level of education and occupation ($p < 0.05$). The mode of recipe preparation was, however, influenced by the family situation, while the parameter CR (recipe composition) was influenced by gender, age, and occupation ($p < 0.05$) (**Table 10**).

The binary logistic regression modeling did not make it possible to identify the determinants or factors associated with the population's perception of the availability (1) or non-availability (0) of the plant in the environment. Indeed, the regression coefficients for each of the variables (age, gender, level of education, and family situation) are not significant ($p > 0.05$).

Multivariate analysis

a. Relationship between diseases and ethnicities

i Hierarchical bottom-up classification between ethnicities and diseases treated

The dendrogram of similarity of five ethnic groups established according to twenty-seven diseases treated with plants by the different populations that make up these ethnic groups highlights two large ethnic groups (**Figure 9**) that are significantly different ($R^2 = 0.9$). The Mbanza ethnic group, located at a Euclidean distance of 18.5, forms the first group, while the second, subdivided into three subgroups, is made up of the Ngbandi, Ngombe, Bomboma, and Lobala ethnic groups, located at a Euclidean distance of 16. It is clear that the Ngbandi population has the same ethnobotanical knowledge as the Ngombe population but is also close to the Bomboma population, which is also close to the Lobala population.

ii Correlation between diseases treated and ethnicity

The correlation matrix between twenty and seven diseases treated and five ethnic groups in the province of South Ubangi (**Figure 10**) reveals five hierarchical classes of diseases: Class 1 (An); Class 2 (Ang, As, Lb, Co, De, Der, Di, Ep, Fo, Fu, Ha, He, Hb, In, La, Ma, Me, Pa, Sp, Vh, Vd, Wl, Yf); Class 3 (Br); Class 4 (Ga) and Class 5 (Td).

b. Relationship between diseases and used plant parts

i Bottom-up hierarchical classification between plant parts used and diseases treated

Two large groups of plant parts used in the treatment of diseases that are very significantly different ($R^2 = 0.98$) are highlighted by the dendrogram resulting from the Hierarchical Clustering between diseases treated and plant parts (**Figure 11**). The leaves of the plants used alone form the first group at a Euclidean distance of 22 from the origin. Flowers, seeds, roots, stems, bark and sap form the second group at a Euclidean distance of 18 from the origin and are subdivided into several subgroups. Flowers, seeds, roots, stems and bark show similarities to sap in the treatment of different diseases.

ii Correlation between diseases treated and plant parts used.

Table 8. Consensus value of diseases and frequency of citation.

Diseases treated	Ethnic groups					CVD	Frequency of Citation
	Bomboma	Lobala	Mbanza	Ngbandi	Ngombe		
Anemia	11	5	2	8	7	0.14	0.17
Angina	0	0	4	0	0	0.02	0.02
Asthma	5	0	0	0	1	0.02	0.03
Lower abdomen	0	0	0	0	2	0.01	0.01
Bronchitis	7	2	0	13	9	0.13	0.16
Tooth decay	0	6	11	0	0	0.07	0.09
Dermatitis	1	0	0	0	0	0.00	0.01
Dehydration	1	0	0	3	1	0.02	0.03
Diarrhea	4	0	2	1	0	0.03	0.04
Epilepsy	0	0	3	0	1	0.02	0.02
Yellow fever	2	2	0	0	1	0.02	0.03
Furuncle	0	0	1	3	2	0.02	0.03
Gastritis	2	10	0	1	5	0.07	0.09
Hemorrhoid	0	5	0	2	1	0.03	0.04
Viral hepatitis	2	0	0	0	2	0.02	0.02
Hypertension	0	6	0	0	4	0.04	0.05
Infections	2	0	0	0	0	0.01	0.01
Low back pain	0	0	1	0	0	0.00	0.01
Malaria	0	0	0	0	2	0.01	0.01
Headache	0	0	1	2	0	0.01	0.02
Edema (feet)	0	0	2	0	0	0.01	0.01
Paronychia	0	0	1	0	0	0.00	0.01
Weight loss	0	0	1	0	0	0.00	0.01
Spleen	1	4	5	3	1	0.06	0.07
Measles	0	0	2	0	0	0.01	0.01
Cough	0	0	4	4	1	0.04	0.05
Vision impairment	2	0	0	0	0	0.01	0.01
Total	40	40	40	40	40	1.00	1.00

Legend: Consensus value of diseases (CVD).

Table 9. Vulnerability index of *Myrianthus arboreus*.

Characteristics		Vulnerability level
C1	Frequency of use: High	3
C2	Plant organ: Leaves, Sap	1
C3	Stage of development: Adult	2
C4	Collection: Picking	3
C5	Pharmaceutical form: Expression and Decoction	3
C6	Biotope: Secondary forest	2
C7	Mode of diaspora dissemination: Sarcochory	3
C8	Morphological type: Tree	3
C9	Abundance: Rare	3
Vulnerability Index (IV)		2.56

Legend: Level 1: Low vulnerability, Level 2: Medium vulnerability, Level 3: High vulnerability [13].

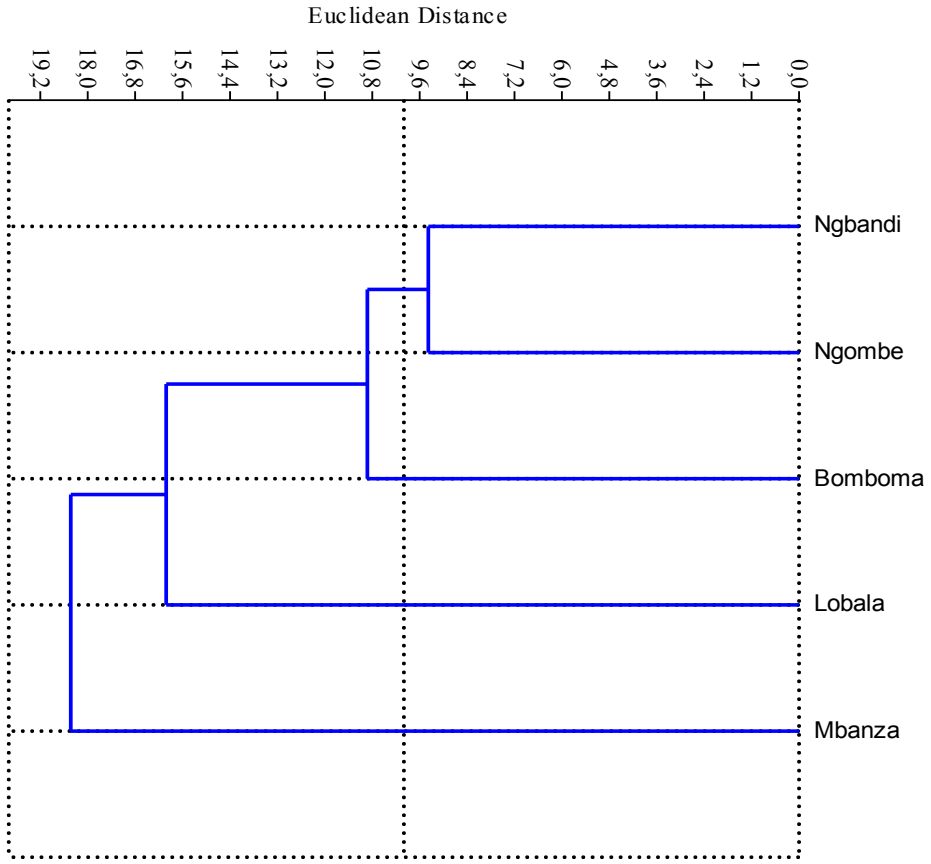

Figure 9. Hierarchical bottom-up classification of five ethnic groups according to diseases treated with plants.

Table 10. Results of the statistical analysis.

Parameters SD	**Statistics**	**PU**	**MS**	**MP**	**VA**	**CR**	**Disponibility**
Gender	*χ2*	4.485	28.241	4.938	4.050	3.992	0.664
	ddl	6	28	3	5	1	1
	p-value	0.611	0.453	0.176	0.542	0.046	0.415
Age group	*χ2*	9.697	71.731	7.974	11.952	6.696	0.939
	ddl	12	56	6	10	2	2
	p-value	0.6435	0.775	0.24	0.288	0.035	0.625
Education level	*χ2*	21.446	118.444	7.708	11.49	1.939	3.941
	ddl	18	84	9	15	3	3
	p-value	0.2585	0.008	0.564	0.717	0.585	0.268
Profession	*χ2*	25.796	236.829	24.925	9.078	14.873	6.522
	ddl	36	168	18	30	6	6
	p-value	0.896	0	0.127	1	0.021	0.367
Marital status	*χ2*	5.003	40.195	9.366	2.704	0.806	0.161
	ddl	6	28	3	5	1	1
	p-value	0.543	0.064	0.025	0.745	0.369	0.688

Legend: PU (part used); MS (disease treated); MP (method of preparation); VA (route of administration); CR (recipe composition).

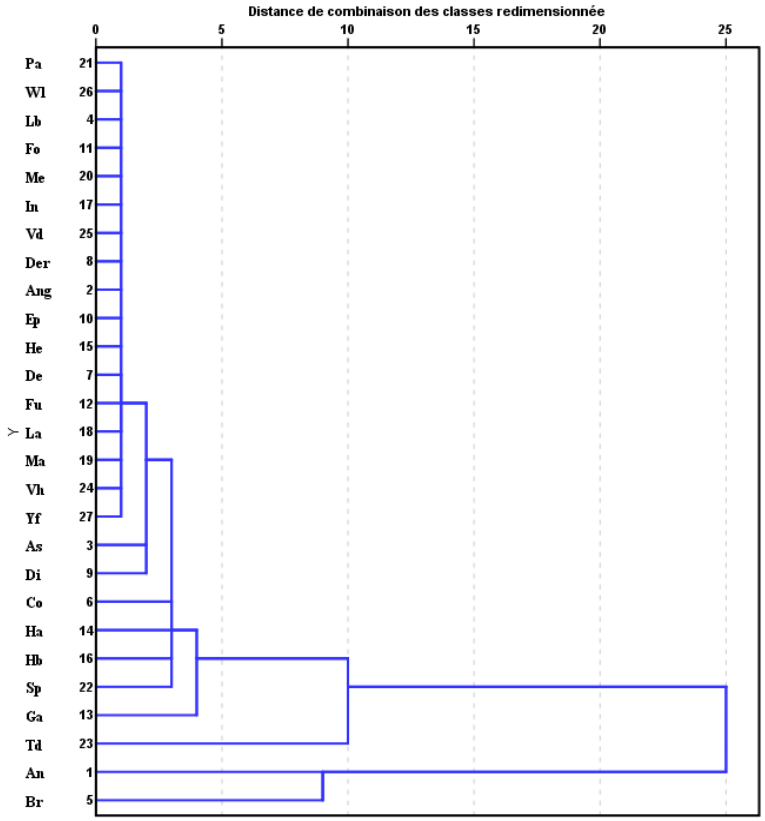

Figure 10. Hierarchical classification diagram displaying relation between twenty-seven diseases treated by five ethnic groups in the South Ubangi province.

Legend: Anaemia (An); Angina (Ang); Asthma (As); Low back pain (Lb); Bronchitis (Br); Cough (Co); Dehydration (De); Dermatitis (Der); Diarrhoea (Di); Epilepsy (Ep); Foot oedema (Fo); Furuncle (Fu); Gastritis (Ga); Haemorrhoids (Ha); Headaches (He); High blood pressure (Hb); Infections (In); Lower abdomen (La); Malaria (Ma); Measles (Me); Paronychia (Pa); Spleen (Sp); Tooth decay (Td); Viral hepatitis (Vh); Visual disturbance (Vd); Weight loss (Wl); Yellow fever (Yf).

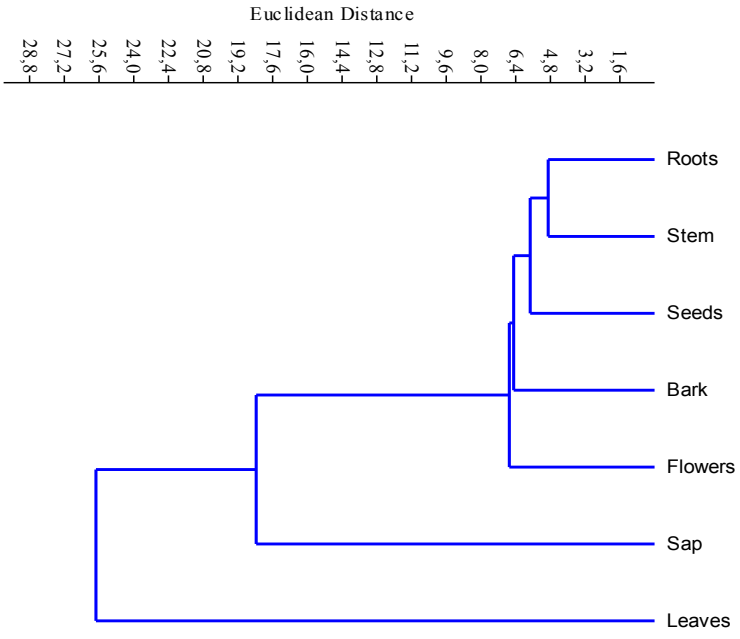

Figure 11. Hierarchical bottom-up classification of diseases treated according to plant parts used.

The different organs of *Myrianthus arboreus* are used to treat five classes of diseases (**Figure 12**): Class 1 (An); Class 2 (Ang, As, Lb, Co, De, Der, Di, Ep, Fo, Fu, Ga, Ha, He, Hb, In, La, Ma, Me, Pa, Vh, Vd, Wl, Yf); Class 3 (Br); Class 4 (Sp) and Class 5 (Td). Class 2 is the most represented with 23 diseases.

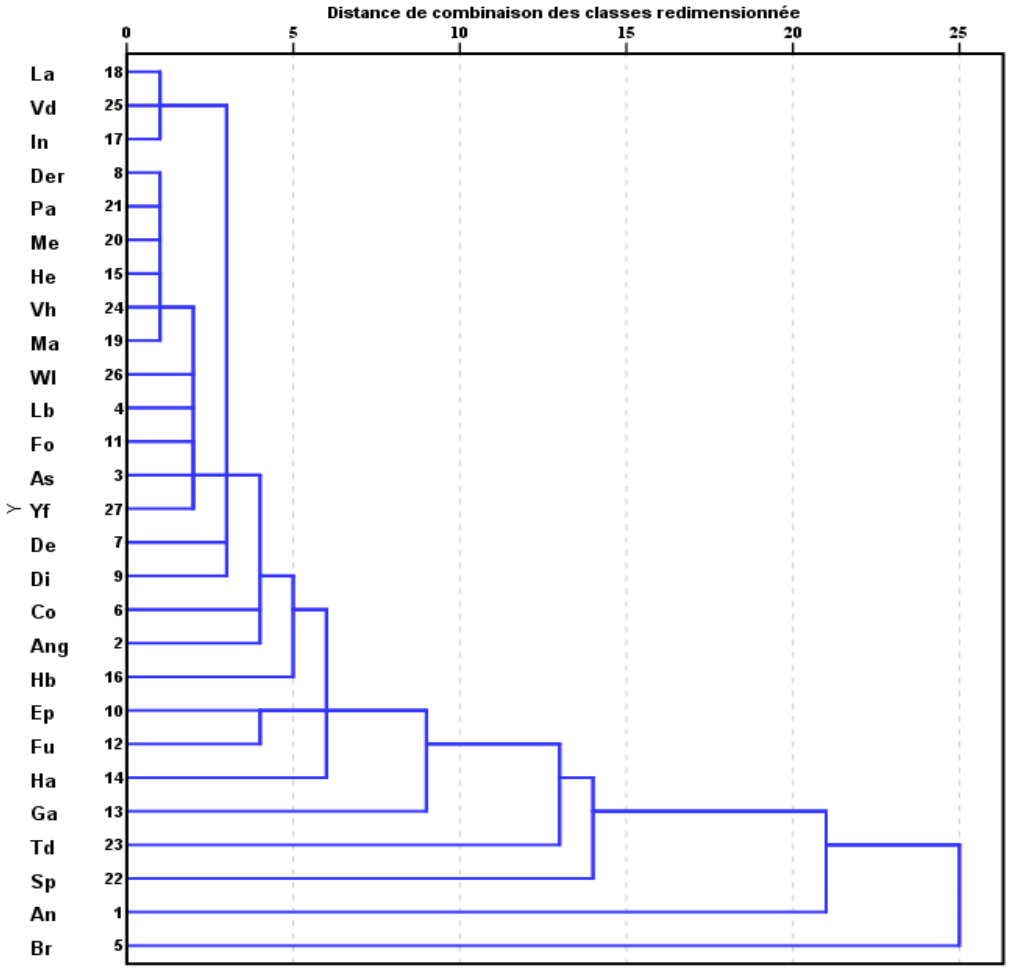

Figure 12. Hierarchical classification diagram displaying relation between twenty-seven diseases treated and plant parts used.

Legend: Anaemia (An); Angina (Ang); Asthma (As); Low back pain (Lb); Bronchitis (Br); Cough (Co); Dehydration (De); Dermatitis (Der); Diarrhoea (Di); Epilepsy (Ep); Foot oedema (Fo); Furuncle (Fu); Gastritis (Ga); Haemorrhoids (Ha); Headaches (He); High blood pressure (Hb); Infections (In); Lower abdomen (La); Malaria (Ma); Measles (Me); Paronychia (Pa); Spleen (Sp); Tooth decay (Td); Viral hepatitis (Vh); Visual disturbance (Vd); Weight loss (Wl); Yellow fever (Yf).

4. Discussion

Myrianthus arboreus P. Beauv. (Cecropiaceae) is an indigenous tree found in the secondary forests of the Ubangi ecoregion of the Democratic Republic of Congo. Its root bark is traditionally used to treat diabetes. Organs such as leaves, stem bark and trunk wood of this plant species contain pentacyclic triterpene acid compounds such as myriaboric acid, ursolic acid, euscaphic acid, tormentic acid, myrianthic acid, myrianthinic acid, arjulonic acid and arboreic acid. The leaves also contain peptide alkaloids such as myrianthin A, myrianthin B, and myrianthin C and phytosterols namely stigmasterol, β-sitosterol and β-sitosterol-3-O-β-D-glucopyranoside. Four pentacyclic triterpenes of the Δ12 ursene type containing the trans-feruloyl moiety namely 3β-O-trans-feruloyl-2α, 19α-dihydroxyurs-12-en-28-oic acid, 3β-O-trans-feruloyl-2α-hydroxy-19α-methoxyurs-12-en-28-oic acid, 2α-acetoxy-3β-O-trans-feruloyl-19α-hydroxyurs-12-en-28-oic acid, 2α-acetoxy-3β-O-trans-(3'-methoxy-4'-formyl)cinnamoyl-19α-methoxyurs-12-en-28-oic acid were also isolated from the root bark of M. arboreus. Phenolic com-

pounds such as protocatechuic acid, myrianthiphyllin, orientin, chlorogenic acid, isoorientin and 3,4-dihydroxybenzaldehyde were isolated from this plant species. Three flavonoids, namely epicatechin, epigallocatechin and dulcisflavan, and two ursan-like triterpenoids, namely euscaphic acid and tormic acid, were also isolated from this plant. Pharmacological investigations of the plant extracts revealed anti-diabetic, wound healing, antibacterial, anti-infectious, antioxidant, antiplasmodial, anticancer and antinociceptive activities [15-18]. Severin et al. [19] reported that *Myrianthus arboreus* is a popular volunteer leafy vegetable in West Africa. This vegetable is of interest because its inclusion in the diet helps prevent cardiovascular diseases. Indeed, Amata [20] reported that the young leaves contain proteins and minerals (calcium, magnesium, potassium, phosphorus, sodium, iron, copper and zinc). The dried seeds or balls of M. arboreus are rich in lipids [21]. These seeds contain trace elements (Fe, Mn, Zn), macroelements (Ca, Mg, P, K), proteins, carbohydrates, dietary fibre, and total polyphenols [19]. The plant has antimicrobial, anti-amoebic, wound healing and antioxidant properties [15,22-24]. In Nigeria, leaf extracts are used to treat diarrhea, vomiting and amoebic dysentery [25]. In the Republic of Congo, chopped leaves are consumed raw with salt to treat pregnancy-related complications and heart disorders [26]. In the western part of the Democratic Republic of Congo, *M. arboreus* is used to treat several diseases including tooth decay, paralysis, epilepsy, external haemorrhoid, convulsions and mental disorder [27]. Apart from convulsions and mental disorders, other diseases are also recognised and treated by the same plant in the Southern Ubangi. Thus, when a plant is used in two different settings for the same purpose, its pharmacological activity will be effective. In North Ubangi, this plant is used to treat monkeypox [28,29]. According to Bobuya et al. [30], the Ngbaka of South Ubangi uses the plant to treat 23 diseases (abscesses, sinusitis, dental caries, wounds, gastritis, hemorrhoids, anemia, amoebic dysentery, vomiting, otitis, eye pain, bronchitis, breastfeeding, back pain, headache, macrocephaly, sickle cell anemia, malaria, lower abdomen, heart palpitations, epilepsy, hernia, and menstrual disorders). The nutritional and pharmaco-biological properties of *M. arboreus* make this biological resource a choice plant material for domestication for *ex situ* conservation.

5. Conclusions

The aim of this study was to assess the ethno-medical knowledge of the Southern Ubangi population on *Myrianthus arboreus* (a plant consumed by chimpanzees). The study found that *M. arboreus* cures 27 diseases; six diseases (anaemia, bronchitis, tooth decay, gastritis, hypertension and spleen) are the most cited. Anaemia and spleen are treated by all socio-cultural groups. The leaf is the most used organ followed by the sap, roots, stems, bark, flowers and seeds. Expression is the most used method of preparation, followed by decoction, maceration and mastication. The oral route is the most used route of administration followed by body bath, massage, anal route and auricular route. *M. arboreus* is a vulnerable species in the study area. The disease treated is influenced by the respondent's level of education and occupation. The mode of preparation of recipes is influenced by the family situation, while the composition of recipes is influenced by sex, age and profession. The Ngbandi ethnic group has the same ethnobotanical knowledge as the Ngombe ethnic group but both are close to the Bomboma and Lobala. The search for new sources of bio-inspired medicines through zoopharmacognosy can thus allow the development of alicaments or nutraceuticals to fight against human diseases but also for the health care of HNPs ex situ. Hence, the need to conduct more in-depth chemical and biological studies on *M. arboreus* with a view to its pharmaceutical valorization according to the principle of access and benefit sharing but also its domestication.

Author Contributions

Conceptualization, P.B. and K.N.N.; Methodology, P.B. and K.N.N.; Formal analysis, D.A., J.D.M.,

M.K., N.K.N., and M.M.; Investigation, M.M; Writing - original draft preparation, P.B., K.N.N. and A.M. Writing - review, and editing, P.B., K.N.N., A.M., C.M., L.L., M.M., D.T., P.T., and V.M. All authors have read, and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare that there is not conflict of interest.

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